FluxSat README FILE (averaged on MERRA grid)

Overview

This document presents a brief description of the FluxSat data products. These are products produced by PI Joanna Joiner. FluxSat (version 2.0) is derived from the MODerate-resolution Imaging Spectroradiometer (MODIS) instruments on the NASA Terra and Aqua satellites using the MCD43C Bidirectional Reflectance Distribution Function (BRDF)-Adjusted Reflectances (NBAR) (Schaaf, 2015). Output is "calibrated" using a set of the FLUXNET 2015 eddy covariance data and has been compared with independent data (i.e., not used in the calibration) as validation. Global Gross Primary Production (GPP) estimates are currently available from March 2000 through present on a best effort basis.

Data Quality Assessment

Users should be aware that the data sets provided here have undergone only a limited amount of validation. FluxSat v1.0 GPP estimates were also compared with other satellite driven data sets such as FLUXCOM and the Vegetation Photosynthesis Model (VPM). Please see Joiner *et al.* (2018) for more details. FluxSat GPP v1.0 data showed less bias and higher precision than other data sets with respect to independent FLUXNET 2015. FluxSat v2.0 was shown to outperform v1.0 (Joiner and Yoshida, 2020).

Known Algorithm Features:

1) The product is only as good as the input MODIS MCD43C reflectances. Any issues with those reflectances will alias into the final GPP product.

2) We are providing data for the pre-Aqua period in which only the Terra satellite is used. We have found that the data quality, particularly in the partial year 2000 is not as good as the period from 2003 (Aqua and Terra) onwards. Users are cautioned when using the Terra-only period data.

Product Description

The FluxSat gridded products are written as a self-describing NetCDF files. The FluxSat v2.0 *native* GPP product is computed at the spatio-temporal resolution of the MCD43C data set (daily at 0.05º spatial resolution, i.e., the so-called Climate Modeling Grid, CMG). Data at the native resolution will be available from the ORNL DAAC. The "MERRA" product is gridded at the MERRA2 spatial resolution.

Note that MCD43C is produced with a rolling 16 day, so data are not truly daily, but are weighted towards the day of interest. Daily data are provided within one monthly file.

The information provided on these files includes: Latitude, longitude, gridbox averaged GPP, and gridbox GPP standard deviation.

Changes from version 1

1. Version 2.0 uses machine learning with MODIS reflectances trained on FLUXNET 2015 data rather than a linear combination of bands (similarly trained) used in v1.0 (see Joiner and Yoshida, 2020). Note that a different training is used in FluxSat v2.0 as compared with what is shown in Joiner and Yoshida (2020). Here, the training was conducted with MCD43C rather than the 1km MCD43D reflectances. All sites used in Joiner and Yoshida (2020) are used in the

final training. Meteorological data are not used in FluxSat v2.0, only MODIS bands 1-7 are used along with an estimate of top-of-atmosphere PAR.

2. GOME-2 SIF was used in v1.0. We found that the low spatial resolution of this data set produced some blocky spatial patterns in the high-resolution data. With machine learning, we found that it was no longer necessary to use GOME-2 SIF, so it is not used in v2.0.

3. Version 2.0 is gap-filled using a climatology developed from the full data set. Gap-filled data are noted within the BRDF quality flag. GPP uncertainties for gap-filled data are set to 2 g C m^{-2} day^{-1}. When daily PAR is very low (typical of dark winter days), GPP gap-filled values and uncertainties are set to zero.

Contact

All questions related to the FluxSat datasets should be directed to Joanna Joiner (Joanna.Joiner@nasa.gov). It would be helpful to send the PI a copy of any publication that uses these data for tracking purposes.

Acknowledgments

We gratefully acknowledge the MODIS data processing teams, particularly the producers of MCD43 (C. Schaaf et al.) for providing the data used here.

References

Joiner, J., **Y. Yoshida**, Y. Zhang, et al. 2018. "Estimation of Terrestrial Global Gross Primary Production (GPP) with Satellite

Data-Driven Models and Eddy Covariance Flux Data." *Remote Sensing*, **10 (9):** 1346 [10.3390/rs10091346]

Joiner, J., and **Y. Yoshida**. 2020. "Satellite-based reflectances capture large fraction of variability in global gross primary production (GPP) at weekly time scales." *Agricultural and Forest Meteorology*, **291:** 108092 [10.1016/j.agrformet.2020.108092]

Schaaf, C., 2015. MCD43D62 MODIS/Terra+Aqua BRDF/Albedo Nadir BRDF-Adjusted Band1 daily L3 global 30ArcSec CMG V006. NASA EOSDIS Land Processes DAAC. 10.5067/modis/mcd43D62.006.